Data-driven cortical clustering to provide a family of plausible solutions to the M/EEG inverse problem

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**Data-driven cortical clustering to provide a family of plausible solutions to the M/EEG inverse problem**

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1 **MOTIVATION**

- Sources are represented as a connected cortical region, rather than a dipole
- Several separated cortical regions can fit the data with similar accuracy. While convex optimization based methods give a single solution, we explore a family of plausible solutions
- Estimate not only the position, but also extension range of the regions

2 **ASSUMPTIONS**

- Data model: \( y = Lx + N \) (\( L \) is a lead field)
- Source space: cortical mesh
- Brain activity \( \mathcal{X} \) : single region with a constant amplitude over this region; one time sample

3 **METHOD**

Adapting hierarchical clustering algorithm [1] to fit M/EEG data:

- Mesh vertices represent initial clusters
- Mesh edges define the cluster neighborhood
- Among all inter neighbors clusters, find clusters \( C_i^*, C_j^* \) which minimize:
  \[
  E(i, j) = \min_a \| y - a \cdot (L(c_i) + L(c_j)) \|_2 + R(i, j)
  \]
- Merge these clusters: \( c_k = c_i \cup c_j, L(c_k) = L(c_i) + L(c_j) \)
- Repeat until the whole cortex is one cluster
- Cut the tree to obtain separated "growing" regions
- Select best regions by thresholding data fitting error

4 **RESULTS**

- Simulated MEG signal of one active region (in blue) with additive noise
- Reconstructed with and without regularization. (we regularized region shapes but other alternatives are possible)
- Obtained 3 spatially separated regions which explain the data with high accuracy (with regul.)
- Estimated the extension range of each region

5 **CONCLUSIONS**

New approach for the M/EEG inverse problem which:

- Deals with a "growing region" object, which allows to explore space of solutions
- Gives several candidates for solution and their extension ranges

Future work:

- Regularization term to be investigated
- Error thresholding to be investigated
- Multiple source case by adapting the MUSIC method [2]

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